XI.—*The Sponge-fauna of Norway; a Report on the Rev. A. M. Norman's Collection of Sponges from the Norwegian Coast.* By W. J. Sollas, M.A., F.G.S., &c.

[Plate VI. & VII.]

In the spring of the year (1879) my friend the Rev. A. M. Norman placed in my hands for description the fine collection of sponges which he had dredged the previous year from the coast of Norway.

This rich material placed completely at my disposal, unhampered by restrictions, has proved so fertile in interesting results that, even with the expenditure of the whole of my leisure time, I have as yet succeeded only in making a beginning to the work of its investigation. It would be useless, however, to defer publication till the investigation is complete; by that time many of the new species which occur in the collection would in all probability have been discovered and described by others, as, indeed, in one or two instances has happened already, and a large part of the labour which has been spent upon them would thus be entirely thrown away.

As regards the general conditions under which the specimens lived, and the circumstances under which they were obtained, I cannot do better than quote nearly entire the graphic description by Mr. Norman himself; he says *, "The district embraced was, speaking roughly, for I do not know the exact mileage, from 15 miles north to 15 miles south of Bergen—the Fiord chosen to the north being Oster Fiord, and the dredging in the south terminating at Kors Fiord.

"The weather was remarkably warm for the time of the year (May), and the circumstances for dredging altogether most favourable.

"Dredging in the Norwegian Fiords is a very different matter from what it is in the ocean round Shetland. In the latter case great expense must be incurred. Exposed to every wind which springs up, in the open sea, with an almost constant heavy Atlantic swell, the employment of a yacht or steamer is absolutely necessary, at least when dredging 20–40 miles from land. After tossing about in such a vessel for a week at sea it often happened that hardly twenty hours' dredging was practicable; and the greatest depth never exceeded 170 fathoms. Compare with this dredging in Norway. A small boat with four men will suffice for our purpose, if fur-

* "The Mollusca of the Fiords near Bergen, Norway," by the Rev. A. M. Norman, M.A., in the 'Journal of Conchology,' Jan. 1879.

nished with suitable apparatus for lightening the labour of hauling in the dredge. In this we lie calmly on the lake-like surface of a narrow Fiord, where we are never more than about a mile from land, and let down the dredge to find a fauna unknown at Shetland, and approximating to that of the deeper parts of the North-Atlantic Ocean. It fairly astounds us at first, after what we have been accustomed to during five-and-twenty years' dredging in our own shallow seas, to drop the dredge over the boat-side and see 400 fathoms of line run out before a resting-place is found at the bottom, and this so near to shore that, letting out as much line again, it is actually possible to pull to shore from this great depth while the dredge lies still where it was let go, to land and haul it in from the rocks, and, if it does not catch (which it probably will do as it mounts the precipice), there to bring it in. It seems incredible until we have proved it, that in pulling over those few hundred yards of smooth surface to the shore we have passed over a precipice of more than 2000 feet, which lies hidden by the calm water which ripples against our bows."

Present condition of the Sponges.—The specimens have been all excellently preserved, some by drying, some by immersion in spirits—the latter still retaining so many details of their original histological character that I found it possible to obtain considerable information with respect to the nature of their soft parts.

Mode of Preparation.—In preparing specimens for microscopical examination I followed the ordinary methods for obtaining the spicules in the free state; but in cutting and mounting "sections" I adopted the processes which have hitherto, in this country at least, been confined to the examination of quite soft tissues. A piece was cut from the sponge large enough to contain a representative of each of its different tissues; this was then soaked in distilled water till its contained alcohol was as nearly as possible all extracted; it was then transferred to a strong solution of gum, in which it was allowed to stand for an hour or so; finally it was placed in the well of a freezing-microtome and frozen in the usual way. From the frozen specimen slices could be cut of any required thinness, the razor, strange to say, passing through the soft tissues and hard spicules with apparently equal ease.

The slices so obtained were variously treated: some stained, and some not, were mounted in glycerine of various degrees of strength; others were treated first with absolute alcohol, then with carbolic acid and turpentine and mounted in Canada balsam.

"Teasing" was resorted to in the case of some tissues with success, especially when it was found desirable to observe the behaviour of the tissue with reagents.

Altogether the various methods pursued have, I believe, succeeded in eliciting nearly all the information that could be extracted from the specimens; and that this is very far from being so complete as could be wished is to a great extent owing to the imperfect manner in which histological characters are exhibited in sponges which have been preserved in spirits without any previous treatment. Mr. Norman's specimens are perfect as spirit-specimens; they were not preserved with a view to submitting them to detailed histological examination. And here it may be worth while suggesting that if in the future it should be desired to preserve sponges with this object, a preliminary soaking in osmic-acid solution of ·02 or ·03 per cent. should be given to them before placing in spirits; this will effect nearly every thing that may be desired. With osmic-acid-treated specimens and the help of a freezing-microtome no difficulty should be experienced in obtaining an almost complete knowledge of the minute structure of any sponge.

We may now proceed with the work of determining and describing species, selecting to begin with the family Tetractinellidæ.

Tetractinellidæ.

Genus Stelletta, Sdt.

Species *Stelletta Normani*, nov.

Sponge (Pl. VI. fig. 1) more or less spherical in shape, becoming depressed cake-like with age, sessile, attached: in size an ellipsoidal form measured $1\frac{6}{10}$ inch in length, $1\frac{1}{10}$ in breadth, and $1\frac{1}{10}$ in height; a cake-like form 2 by $1\frac{1}{2}$ by $\frac{3}{4}$ inch. From the surface of the sponge the distal ends of long acerate spicules project erectly, rendering it hispid; trifid spicules accompany the acerates, and, expanding into triradiate heads with simple or bifurcated rays at about one and the same level, form a network-like covering concentric with the surface and about $\frac{1}{25}$ inch above it. Entangled among and adhering to the ends of these spicules are numerous Foraminifera, Annelids, and other organisms, as well as mineral particles; these give a dark greyish colour to the sponge, while its actual surface is of a yellowish-white colour. Oscules not apparent. Pores numerous, dispersed, minute.

Skeleton.—The skeleton consists of long-shafted spicules, minute hair-like spicules, and stellates. The long-shafted

spicules may be divided into two groups, the robust and the slender.

Thick long-shafted Spicules.—(i) a simple fusiform, straight or slightly curved, sharply pointed acerate, 0·235 inch long, 0·0025 inch broad (Pl. VI. fig. 4); (ii) trifid spicule with simple rays, shaft 0·16 inch long, 0·0025 broad, arms 0·03 inch long (Pl. VI. fig. 5); (iii) trifid spicule with bifurcated arms, shaft 0·11 inch long, 0·00375 broad, arms 0·0375 inch long (Pl. VI. figs. 6, 8).

Thin long-shafted Spicules.—(i) a long, slender, sharp-pointed acerate, 0·23 inch long (Pl. VI. fig. 11); (ii) trifid spicule with forward-directed arms, 0·215 inch long (Pl. VI. fig. 10); (iii) trifid, with arms recurved, anchor-like, 0·216 inch long (Pl. VI. figs. 9, 15); (iv) trifid spicule with forward-directed arms, 0·0625 inch long (Pl. VI. fig. 7). All these spicules are about 0·00125 inch broad. No. iv is no. iii of the preceding group in miniature.

Stellates.—These are of two kinds:—one somewhat larger, 0·0013 inch in diameter, with fine pointed rays (Pl. VI. fig. 13); the other smaller, 0·0004 inch in diameter, with blunt-ended rays and less regular in form (Pl. VI. fig. 12). Bowerbank's term "cylindro-stellate" may be adopted for the latter.

Hair-like Spicules or Trichites.—The "trichites," as these fine, immeasurably thin, hair-like spicules may be termed, are usually collected together in cylindrical sheaves or bundles, from 0·0016 to 0·002 inch long, and 0·0008 inch broad (Pl. VI. figs. 14, 16): each sheaf appears to represent a cell, and the spicules siliceous rhaphides within it; the unmetamorphosed protoplasm of the sheaf is chiefly accumulated in a layer at each end; one of these layers contains a nucleus with a spherical nucleolus. With age the trichites appear to become separate and are freed from their surrounding envelope. Their length is the same as that of the bundle which they form.

Hab. Marine.

Loc. Kors fiord, Station 23, depth 180 fathoms.

In transverse section the sponge is seen to consist of an internal "mark" (body-substance), separated by a layer of crypt-like cavities from an external well-marked cortex (Pl. VI. fig. 2). The cortex is about $\frac{1}{15}$ inch thick; its lower half consists of a layer of bluish-white translucent tissue of great toughness and elasticity, and bearing a superficial resemblance to cartilage.

The "mark" is of a yellowish-grey colour, and traversed by canals which branch and become smaller towards the sub-

cortical crypts. The crypts are separated from each other by a number of fleshy pillars traversed by the shafts of long acerate and trifid spicules; they communicate laterally, to form a subcortical layer of winding passages.

Under the microscope the transverse section shows an outermost structureless membrane succeeded by a layer of minute stellates*, the two together having a thickness of 0·0004 inch (Pl. VII. fig. 18, *a*). A layer of connective tissue with scattered stellates and of variable thickness succeeds.

The next layer, 0·03 inch thick, consists chiefly of trichite sheaves arranged in packets—the spaces around and between the packets, but not about the separate sheaves, being filled up with gelatinous connective tissue, the corpuscles of which are fusiform (Pl. VII. fig. 18, *b*).

The cartilaginous-looking layer (Pl. VII. fig. 18, *c*) before mentioned next succeeds; it is about 0·03 inch thick, and consists of long fusiform transparent hyaline fibres with a more refringent, faintly bluish, axial thread: these appear to be muscle-fibres, and form variously oriented fasciæ lying chiefly in a plane parallel to the general surface of the sponge (Pl. VI. fig. 3).

Just within the proximal edge of the preceding or muscular layer is a discontinuous row of large cells, variable but chiefly elliptical in form, and provided with a large oval nucleus containing some fluid and a spherical nucleolus (Pl. VII. figs. 18, *f*, & 26).

The inner or proximal face of the muscular layer is covered by an epithelial membrane bearing round nuclei.

The "mark" has a very different appearance from that of the gelatinous connective tissue which forms a large part of some sponges; it consists of finely granular protoplasm, which readily stains with reagents: about the borders of the canals it appears fibrous, owing to the presence of a number of granular fusiform corpuscles arranged in parallel order; further away from the canals nuclei present themselves similar in appearance to those which occur in the cells on the innermost face of the muscular layer; and in some cases the outlines of large elliptical cells can be traced about these nuclei; but more often the borders of the cells are obscure (Pl. VII. fig. 24).

The pillars of the crypts are chiefly continuations upwards of the mark; but they also contain muscular fibres, lying longi-

* Whether the external membrane represents a layer of plate-like epidermis, or whether it and the stellates together constitute the epidermis, is by no means clear. The stellates have much the appearance of being the contents of epidermal cells.

tudinally, which have found their way down from the muscular layer. It is through the pillars that the long-shafted spicules pass on their way to the surface.

The large elliptical cells of the underside of the muscular layer are continued out of it down the sides of the pillars and under the floor of the crypts.

The cortex is traversed by the "intermarginal cavities" of Bowerbank, or, as I shall term them, the "cortical funnels" or "chonæ"*. They consist essentially of a tube divided by a sphincter into a shorter proximal and a longer distal part, the "ectochone" and "endochone" respectively (Pl. VII. fig. 18, *e*). The ectochone is cylindrical or acutely conical for the greater part of its length, its proximal end being either the hemispherical termination of the cylinder or the rounded apex of the cone; its distal end is greatly expanded beneath the dermal layer, and produced laterally into canals from which smaller canals proceed and terminate in the pores of the surface, either immediately or after once more subdividing into still smaller canals. The endochone is a more or less hemispherical dome, which may be prolonged downwards as a very short cylindrical or conical tube, and which opens freely into the subcortical crypt. Generally each crypt is furnished with two or more funnels. The distal half of the ectochone lies in the layer of trichite sheaves; its proximal half and the whole of the endochone lies in the muscular layer of the cortex. The funnels are lined by an epithelial layer, outside which is a layer of concentric muscle-fibres; but when the ectochone traverses the layer of trichite-sheaves, the concentric muscles are replaced by gelatinous connective tissue containing fusiform corpuscles with nuclei.

Arrangement of the Spicules.—The long-shafted spicules which occur in the mark are chiefly robust acerates, gathered together into loose fibres, which exhibit no regular arrangement; on approaching the cortex, however, the fibres arrange themselves along radii more or less at right angles to it, pass through the pillars of the crypts, traverse the cortex, and project beyond it. At the same time trifid spicules put in an appearance, their distal triradiate ends lying imbedded at all levels in the cortex, or expanding at some distance outside it. Where the fibres pass out of the sponge their constituent spicules have so much diverged from one another that the fibre-like form is lost; the dermal layer of the sponge is slightly raised, tent-like, about the fibre where it emerges. The small trifid spicules (Pl. VI. fig. 7) are almost con-

* χώνη, a funnel.

fined to the upper corners of the crypts, to which they serve as a kind of groin; the arms of large trifids sometimes occur in the same position, and where both are absent their place is sometimes supplied by a projecting spur produced from the shaft of one of the robust trifids (Pl. VI. fig. 8).

Stellates.—The cylindro-stellates are most abundant in the dermal layer, where the sharp-rayed forms are rare; both kinds of stellates are thickly strewn around the walls of the crypts, and both are rare in the interior of the mark. The sharp-rayed forms preponderate in the mark.

Trichites.—The trichite sheaves occur as the chief constituents of the outer half of the cortex; they accompany the large spicules through the pillars of the crypts, and are abundantly dispersed throughout the general substance of the mark.

Foreign Bodies.—The mark contains a surprisingly large number of foreign bodies imbedded in its substance. The nature of these included bodies is very various; but, for the most part, they consist of tests of Foraminifera, Radiolaria, and Diatoms, and the calcareous and siliceous spicules of a variety of other sponges, including an occasional *Geodia* globule.

Observations.

1. *The Muscular Layer.*—Before proceeding to describe this a little more fully than we have yet done, it may be worth while giving a short account of observations which have been already made by others on the occurrence of muscular tissue in the sponges.

Lieberkühn * appears to have been the first to draw attention to the resemblance between certain sponge-tissues and unstriated muscle-fibre, as in his description of the fibrous layer of the cortex in *Tethya lyncurium*, where he says that the fibres of this layer may be regarded as related to the so-called organic muscle-fibre of the higher animals.

Oscar Schmidt † follows, quoting Lieberkühn, confirming his observations, and extending them to other species, *ex. gr. Ancorina cerebrum*, Sdt.

Kölliker ‡ likewise describes the muscular tissue of certain rind-sponges.

O. Schmidt § again discusses this subject, confirming, by his own observations on the intermarginal cavities of *Geodia gigas*, Sdt., those made by Bowerbank on his *Geodia Baretti*,

* Leiberkühn, 1859, Archiv f. Anatomie u. Physiologie, p. 523.

† O. Schmidt, 1862, Die Spong. d. Adriatischen Meeres, p. 43, pl. iv. fig. 1, *a*, *b*.

‡ Kölliker, 1864, Icon. Histolog. i. Heft, p. 48.

§ O. Schmidt, 1866, Adriat. Spong. ii. Supplem. p. 3.

from which it appeared that the iris-like diaphragms extending across these cavities are capable of spontaneous contraction and expansion, so as to vary at will the size of the central lumen; and hence he draws the obvious inference that the fusiform fibres composing these diaphragms are not only morphologically similar to muscle-fibres, but physiologically as well; from this he proceeds to the conclusion that the fibres of *Tethya* and other rind-sponges are likewise muscle-fibres.

Häckel * does not deny that the fusiform fibres are both irritable and contractile, in the sense of shortening in the long and broadening in the transverse direction; but he maintains that true muscle cannot be evolved without a simultaneous differentiation of nerve-tracts; and since specialized nerve-tracts do not exist in sponges, he would call the contractile fibres in question "neuro-muscles."

Carter † describes the fusiform cells, referring to his figures in the Ann. & Mag. Nat. Hist. 1872, vol. x. pl. vii. figs. 9, 10, in illustration. These cells are less specialized than those to be met with in many other instances (they resemble fusiform connective-tissue corpuscles); but Carter decides to regard them provisionally as muscular.

F. E. Schulze ‡ figures and describes fusiform cells also from an *Aplysina* (*A. acrophoba*); he follows Häckel in refusing to designate them as muscle-fibres, preferring the term "contractile fibre-cells."

Carter §, in his account of *Axos spinispiculum*, Carter, describes some fibrillated fibres which he conjectures may be muscular, especially as they lie parallel to each other and are not united as in elastic tissue.

In *Stelletta Normani* the fibres are the best marked I have yet met with in any sponge, and they likewise most closely resemble the organic muscle-fibres of the higher animals; they are about 0·0066 inch long and 0·0003 broad, fusiform, hyaline, colourless, and of sharply marked contour; their nucleus or axial thread, as it may be more correctly termed, is fusiform, homogeneous, faintly bluish in colour, highly refringent, and 0·0035 inch long (Pl. VII. fig. 20). With polarized light the fibres behave like uniaxal crystals. Treated with acetic acid or boiled in water they undergo no appreciable change; but potash and nitric acid produce well-

* Häckel, 1872, Die Kalkschwämme, p. 414.

† Carter, 1875, Ann. & Mag. Nat. Hist. ser. 4, vol. xvi. p. 36.

‡ Schulze, 1878, Zeitschrift f. wiss. Zool. p. 394, pl. xxii. fig. 13.

§ Carter, 1879, Ann. & Mag. Nat. Hist. ser. 5, vol. iii. pp. 287 and 290, pl. xxv. figs. 6–8.

marked effects. Thus on adding a 5 or 10 per cent. solution of potash to a fragment of the teased-out tissue, the fibres at once became swollen, those which were previously curved straightened themselves out, and simultaneously the axial thread almost completely disappeared; on then adding a 10 per cent. solution of nitric acid the fibres at once contracted, and the axial thread became more visible than it had been before; again adding potash the fibre expanded; again nitric acid, and it contracted; and as often as one or the other reagent was applied, so often the same results were produced. With strong acid the outlines of the fibres appeared to vanish, and a homogeneous substance remained behind, in which the axial thread remained wonderfully clear and distinct; on adding magenta, the threads stained deeply, but the matrix was not affected. The fibres can best be separated from their tissue by macerating thin slices for a few days in baryta-water or 1 per cent. chromic-acid solution, and then teasing out.

The muscular layer passes at its distal margin insensibly into gelatinous connective tissue with fusiform corpuscles. The change seems to be accomplished by the loss of a distinct border to the muscle-fibres, and the growth of the fusiform axial thread at the expense of their hyaline portion; at the same time a distinct but small nucleus and nucleolus become clearly visible in the axial thread, which has also acquired a granular character (Pl. VII. fig. 17).

The muscles of the sphincter are darker than those of the rest of the muscular layer, owing to the increased size and proximity of their axial threads and to the development of fine granules in their hyaline exterior.

With carmine or magenta the axial threads of the muscle-fibres are easily stained, but the hyaline part not at all; hence when a section of the muscular layer is stained, the sphincters are made very prominent, since their abundant nuclei lead them to acquire a very dark colour.

We have applied the term muscle-fibres to the structures just described, because they are morphologically similar to the fibres occurring in other animals to which no one hesitates to apply the term "muscular;" and the fact that, slightly modified, they enter into the composition of the sphincters of the cortical funnels seems to show that they are functionally muscles as well. If, then, functionally and morphologically they resemble the organic muscles of other animals (and Kölliker, Oscar Schmidt, Häckel, and F. E. Schulze all seem agreed upon this point), one sees no good reason for withholding from them the name muscular. The specializa-

tion which converts an indifferent cell into a muscular fibre consists simply of a limitation of its contractility to a particular direction, so that it contracts in a longitudinal and broadens out in a transverse direction; its irritability is by no means suppressed; and, as is well known, both striated and unstriated muscles are capable of responding to thermal, chemical, and mechanical stimuli, quite independently of any nervous stimulus. This being so, all muscles, both those connected and those not connected with a nervous apparatus, may be regarded as neuro-muscles; and I, for my part, do not see what is to be gained by introducing this term into our nomenclature; it seems to imply that in the muscles of the higher animals something, some property, has been lost which was present in the muscles of such animals as are without a nervous supply; while we know this not to be the case. Of course a nerve is in a very different case; the tissue which has been converted into a nerve has not only gained an enhanced irritability, but has lost all trace of contractility; and if we found a nerve possessing contractility we might begin to think of coining some new term to distinguish it from the more highly specialized tissue. The inconvenience which would attend the recognition of muscles and "neuro-muscles" as distinctly different tissues may be illustrated by the observation of Engelmann, who states that the middle third of the ureter of the rabbit contains no discoverable nervous structures, and yet exhibits automatic and rhythmical contractions*. Surely we cannot be expected to call the muscles of this part of the ureter by a different name from those otherwise quite similar ones of the rest of that structure.

Whatever our opinions with regard to nomenclature may be, the difficulty of explaining the manner in which the muscular layer of our sponge receives its stimuli remains the same; it is so important a tissue of the sponge, so perfectly differentiated, that one can hardly believe associated nerve-structures to be absent; and yet I have not been able to discover any trace of the presence of such structures. The large elliptical cells underlying the muscular layer and surrounding the subcortical crypts are wonderfully like ganglionic cells; but though they sometimes are elongated in one or other direction into a tear-drop shape, yet they are never prolonged into any distinct thread which might be regarded as a nerve. They do not seem to be nerve-cells; and perhaps they may be "ova;" but without tracing their development it is impossible

* Foster, Text-book of Physiology, 1878, p. 83.

to say. On the whole I am disposed to regard them as the ordinary cells of the mark rendered very distinct by their occurrence in a tissue of markedly contrasted character. The spicules which extend beyond the surface of the sponge might perhaps suffice to convey a mechanical stimulus to the muscular layer, though this view is certainly attended with serious difficulties.

2. *Cortical Funnels or Chonæ.*—As the nomenclature of these organs is somewhat varied, one might almost say "poikilitic," a short account of the various terms in use may not prove superfluous. Most authors have founded their terminology on their ideas of the homology of these organs with the intermarginal cavities of Bowerbank; and while this plan has its special merits it suffers from the serious drawback that ideas as to homology are liable to change with advancing knowledge, the nomenclature must perforce change with them, and changes in nomenclature are most undesirable. Carter * abstains from committing himself and merely terms these tubes the hourglass-shaped openings or hourglass cavities. Bowerbank † and Oscar Schmidt ‡ regard them as corresponding to the intermarginal cavities of other sponges, such as *Chalina* and *Spongilla*, though they do not say why the "cortical funnels" and "subcortical crypts" should not both together be regarded as representing the intermarginal cavities. Häckel § appears to share the views of Bowerbank and Schmidt, but is anxious above all things to make it clear that the intermarginal cavities are nothing more than modifications of the ordinary "Astcanäle," one of the bladders of the "blasenförmige" type of "Astcanal" which has become specialized; and he prefers to call them "subdermal cavities," a term synonymous with Bowerbank's intermarginal cavities. Perhaps I am wrong in thinking that the homology of these cavities is not quite clear; but, however this may be, and without wishing "to ascribe any essential significance to them whatsoever," I still think they are sufficiently specialized parts of the canal-system and sufficiently different from other subdermal cavities to deserve a distinct name; and as "cortical funnel (*chone*)" is expressive without involving theoretical considerations, I have ventured to make use of it. Häckel compares the sphincters of the funnels to the transitory sphincters which are formed by the closing of the dermal pores and gastral ostia of some calca-

* Carter, Ann. & Mag. Nat. Hist. 1869, ser. 4, vol. iv. p. 13.
† Bowerbank, Brit. Spong. vol. i. p. 101.
‡ O. Schmidt, Adriat. Spong. ii. Suppl. p. 4.
§ Häckel, Kalkschwämme, p. 236.

reous sponges. That an analogy exists is indubitable; but the sphincters of *Geodia* and the like are not transitory, any more than those of the ostia of some sponges, and they are besides composed of far more highly specialized muscle-fibres, arranged in a much more complex layer than is the case with the fusiform contractile cells which serve to close the dermal pores or ostia of any sponge which I have examined.

The following table gives the equivalent terms used by different authors, in four columns: the first gives the terminology of Bowerbank, O. Schmidt, and others; the second that of Carter and partly of Johnston; the third of Häckel; and the fourth that adopted here.

1.	2.	3.	4.
Pores.	Apertures.	Hautporen.	Pores.
Distal end of intermarginal cavity.	Pores.		
Intermarginal cavity.	Hour-glass cavity.	Subdermal cavity.	Cortical funnel (chone).

3. *The Trichites.*—These spicules form a layer which is completely homologous with the layer of globates in *Geodia* and the like; and we may regard the trichite sheaf itself as homologous with the globate spicule: in the one the trichites have a radiate arrangement, and are fused together in a round ball; in the other they remain separate from each other and, lying parallel one with another, form a cylindrical bundle.

Certain structural differences distinguish the trichite-layer from the globate, independently of differences in the spicular elements themselves; thus in the *Geodia*-type of rind the globules are united by ligaments of fine sarcodic (muscular?) filaments, while in our *Stelletta* the trichite sheaves are not connected with each other by any intermediate tissue, but simply lie loose in "pockets" of their layer. In both the globate and trichite layers, however, certain spherical cells lie amidst the spicules; in the trichite layer these cells are very similar to colourless blood-corpuscles, and possess a nucleus with a round nucleolus; the corresponding cells in the globate layer are of a somewhat different character, as will be noticed in our description of the *Geodia* rind.

In examining sections of the trichite layer one constantly meets with examples like that shown in Pl. VI. fig. 16, where the trichites remaining conjoined at one end have separated and diverged at the other, and, dividing the sarcode of this end between them, appear capitate with minute bead-like particles of it.

Trichite sheaves are common in a variety of sponges, especially among the Esperiadæ. Oscar Schmidt * has described the structure of those which occur in *Esperia lucifera*, Sdt.; he, however, represents the nucleus as occurring at the side of the sheaf, and not at the end, as shown in my drawings. The enclosing cell-membrane is also more distinct in his figures than I have yet seen it. Possibly his specimens represent an earlier stage in the history of the sheaf than mine, and the nucleus may subsequently become transferred from the side to the end of the cell. In Schmidt's fig. 21, which represents a mature cell, this, however, does not appear to be the case, and we must probably fall back on inherent differences in the spicule-sheaves of the two sponges.

4. *Foreign Particles.*—The congregation of foreign particles on the exterior of the sponge, and their abundant distribution within it, are very striking facts, though not by any means confined to this species or genus; as one observes the numerous remains of organisms imbedded in the sarcode of the mark one can scarcely refrain from regarding them, like the wings of flies in a spider's web, as the remnants of previous feasts. The cortex is so admirably adapted for preventing the entrance of foreign bodies, especially of the size of those under consideration, that it is difficult in the extreme to see how those within the mark can have found their way there unless through the cooperation of the sponge itself. If this theoretical view be the true one, then we may further regard the forked ends of the projecting spicules as serving not only for a means of defence, but as actual traps for capturing prey and so securing a constant supply of highly proteinaceous food for the sponge.

5. *Classification.*—Of all the various species of the genus, *Stelletta Normani* is provided with the most complete equipment of spicules; and no difficulty is likely to be encountered in its identification.

The following list of the already published species of *Stelletta* may prove useful for reference. I have not included in it those species of Bowerbank's *Ecionema* and *Tethya* which may probably turn out to be *Stelletta*, because I think this genus cannot last much longer without undergoing modification, and I am anxious not to transfer Bowerbank's species to it till both it and they have been subjected to revision.

* Zoologische Ergebnisse der Nordenfahrt vom 21. Juli bis 9. September 1872, p. 120, pl. i. figs. 19–21.

Table of the Species of Stelletta.

I. Species possessing ternate spicules with furcate rays.

S. immunda, Sdt. 1862, Spong. d. Adriat. Meeres, Taf. iv. fig. 3. Syn. *S. Wageneri*, Sdt.

S. Helleri, Sdt. 1864, Suppl. Spong. d. Adriat. Meeres, Taf. iii. fig. 8.

S. aspera, Carter, 1871, Ann. & Mag. Nat. Hist. ser. 4, vol. vii. pl. iv. figs. 7–13.

S. lactea, Carter, 1871, Ann. & Mag. Nat. Hist. ser. 4, vol. vii. pl. iv. figs. 17–21.

S. mucronata, Sdt. 1868, iii. Suppl. Spong. d. Adriat. Meeres, Taf. iv. fig. 2.

S. scabra, Sdt. 1868, iii. Suppl. Spong. d. Adriat. Meeres, Taf. iv. fig. 5.

S. agariciformis, Sdt., is *Thenea* (Gray) *Wallichii* (Perceval Wright).

S. discophora, Sdt., and *S. mammillaris*, Sdt., are probably *Geodiæ*.

II. Species without furcated ternates, with ternate anchor-like spicules.

S. dorsigera, Sdt. 1864, Suppl. Spong. d. Adriat. Meeres, Taf. iii. figs. 6, 7. (Doubtful whether genuine recurved rays.)

S. Grubii, Sdt. 1862, Spong. d. Adriat. Meeres, Taf. iv. fig. 2. (Rays "*raro furcatis*").

S. pachastrelloides, Carter, 1876, Ann. & Mag. Nat. Hist. ser. 4, vol. xviii. pl. xv. fig. 40.

S. pumex, Sdt. 1864, Suppl. Spong. d. Adriat. Meeres, Taf. iii. fig. 9.

III. Species without either furcate or anchor-like ternate spicules.

S. Boglicii, Sdt. 1862, Spong. d. Adriat. Meeres, Taf. iv. fig. 3.

S. pathologica, Sdt. 1868, iii. Suppl. Spong. d. Adriat. Meeres, Taf. iii. figs. 3, 4.

S. anceps, Sdt. 1868, iii. Suppl. Spong. d. Adriat. Meeres, p. 31.

NOTE.—*S. euastrum*, *geodina*, and *intermedia* of Schmidt appear to belong to *Geodia*. O. Schmidt * would regard as

* III. Suppl. Spong. d. Adriat. Meeres, pp. 20, 21.

Geodiæ only those sponges which contain globates, but no stellates, either in the rind or parenchyma; it is to be feared that the genus *Geodia* would be denuded of the majority of its species if this definition were rigidly carried out.

EXPLANATION OF THE PLATES.

Plate VI.

Fig. 1. *Stelletta Normani*, sp. nov. A very little larger than natural size. (From a photograph.)
Fig. 2. Transverse section (× 2). From a photograph.
Fig. 3. Tangential section of the muscular layer, showing the arrangement of its fasciæ: *a*, sphincter; *b*, *c*, transverse section of spicules.
Fig. 4. Robust acerate spicule.
Fig. 5. Robust simple ternate spicule.
Fig. 6. Bifurcated ternate spicule.
Fig. 7. Small simple ternate spicule.
Fig. 8. Bifurcated ternate, with a lateral spur.
Fig. 9. Slender anchor-like ternate.
Fig. 10. Slender ternate spicule, a variety with only two rays.
Fig. 11. Slender acerate spicule. Figs. 4–11 are all magnified 20 diameters.
Fig. 12. Cylindro-stellate spicule.
Fig. 13. Sharp-rayed stellate.
Fig. 14. Trichite sheaf, mounted in Canada balsam. Figs. 12–14 are multiplied 435 diameters.
Fig. 15. Head of anchor-like ternate (× 140).
Fig. 16. Trichite sheaf, mounted in glycerine, showing the divergence of the trichites, which are tipped with sarcode (× 571).

Plate VII.

Fig. 17. Fusiform corpuscle containing nucleus and nucleolus, from the connective tissue of the cortex (× 435).
Fig. 18. Transverse section of the cortex: *a*, epidermal layer, with stellates; *b*, trichite layer; *c*, muscular layer; *d*, subcortical crypt; *e*, ectochone; *f*, layer of large granular cells (× 15).
Fig. 19. Axial thread of a muscle-fibre from teased-out tissue which has been treated with strong nitric acid and then stained (× 435).
Figs. 20, 20 *a*. Muscle-fibres isolated after treatment with lime-water by teasing (× 435).
Fig. 21. Trichite sheaf in glycerine: *a*, terminal layer of sarcode, containing nucleus and nucleolus (× 435).
Fig. 22. The frayed end of a teased-out bundle of muscle-fibre which had been treated with chromic acid (× 435).
Fig. 23. Cells of the mark, surrounding a small canal (× 217).
Fig. 24. Wall of a large canal, showing connective tissue with fusiform corpuscles and scattered stellates on the exterior, and granular cells further in (× 217).
Fig. 25. Transverse section of a bundle of muscle-fibre (× 315).
Fig. 26. Granular cells, with nucleus and nucleolus, from the lower face of the muscular layer (× 435).

[To be continued.]